

AMENDMENTS TO THE CLAIMS

Claims 1-82 were filed originally and claims 31-35 and 47-53 were previously canceled as being directed to non-elected claims. Thus, claims 1-30, 36-46, and 54-82 were pending at the time of the Action.

Claims 7-8, 25-26, 38-39, 54-61, 66-70, and 72-82 are canceled.

Claims 1, 9, 11-13, 17, 20, 27, 36, 40, 42-44, and 62-65 are amended.

Accordingly, claims 1-6, 9-24, 27-30, 36-37, 40-46, 62-65, and 71 remain pending.

1. (Once Amended) A method comprising:

transforming frames in a video sequence using a wavelet transform and motion information between frames to produce multiple sub-bands of coefficients; and

coding the coefficients of each sub-band independently bit-plane by bit-plane using different coding primitives, wherein the coding primitives comprise:

zero coding to code new information about a coefficient that is not yet significant in a previous bit-plane; and

sign coding to code a sign of the coefficient once the coefficient is deemed significant.

2. (Original) A method as recited in claim 1, wherein the wavelet transform comprises a shape-adaptive discrete wavelet transform.

1           **3. (Original)** A method as recited in claim 1, wherein the transforming  
2 comprises performing a temporal 1-D wavelet transform along motion trajectories  
3 in a temporal direction.

4  
5           **4. (Original)** A method as recited in claim 1, wherein the transforming  
6 comprises:

7           performing a temporal wavelet transform on corresponding pixels in a  
8 video object along motion trajectories in a temporal direction to produce frames of  
9 temporal wavelet coefficients; and

10           performing a spatial wavelet transform on the frames of the temporal  
11 wavelet coefficients to produce multiple sub-bands of wavelet coefficients.

12  
13           **5. (Original)** A method as recited in claim 1, wherein the coding  
14 produces multiple bitstreams, one for each sub-band, and further comprising  
15 forming a bitstream from the multiple bitstreams.

16  
17           **6. (Original)** A method as recited in claim 1, wherein the coding  
18 comprises transposing selected sub-bands.

19  
20           **7. (Canceled)**

21  
22           **8. (Canceled)**

1           9.    ~~(Once Amended)~~ A method ~~as recited in claim 7~~, comprising:  
2               transforming frames in a video sequence using a wavelet transform and  
3               motion information between frames to produce multiple sub-bands of coefficients;  
4               coding the coefficients of each sub-band independently bit-plane by bit-  
5               plane using different coding primitives, wherein the coding primitives comprise:

6                     zero coding to code new information about a coefficient that is not  
7                     yet significant in a previous bit-plane;

8                     sign coding to code a sign of the coefficient once the coefficient is  
9                     deemed significant; and

10                    magnitude refinement to code new information of a coefficient that  
11                    has already become significant in the previous bit-plane.

12  
13           10.    (Original) A method as recited in claim 1, wherein the coding  
14           comprises assigning contexts to the coefficients of each sub-band based on  
15           numbers of significant neighboring samples.

16  
17           11.    ~~(Once Amended)~~ A method ~~as recited in claim 10~~, comprising:  
18               transforming frames in a video sequence using a wavelet transform and  
19               motion information between frames to produce multiple sub-bands of coefficients;  
20               coding the coefficients of each sub-band independently by assigning  
21               contexts to the coefficients of each sub-band based on numbers of significant  
22               neighboring samples;

23                    wherein the sub-bands include an LLL (low-low-low) sub-band and an  
24                    LLH (low-low-high) sub-band and the contexts are assigned as follows:  
25

LLL and LLH Sub-bands				
h	v	a	d	Context
2	x	x	x	0
1	$\geq 1$	x	x	0
1	0	$\geq 1$	x	1
1	0	0	x	2
0	2	0	x	3
0	1	0	x	4
0	0	$\geq 1$	x	5
0	0	0	3	6
0	0	0	2	7
0	0	0	1	8
0	0	0	0	9

where "h" represents a number of immediate horizontal neighbors that are significant and  $0 < h < 2$ , "v" represents a number of immediate vertical neighbors that are significant and  $0 < v < 2$ , "a" represents a number of immediate temporal neighbors that are significant and  $0 < a < 2$ , and "d" represents a number of immediate diagonal neighbors that are significant and  $0 < d < 12$ .

12. (Once Amended) A method as recited in claim 10, comprising:  
transforming frames in a video sequence using a wavelet transform and motion information between frames to produce multiple sub-bands of coefficients;  
coding the coefficients of each sub-band independently by assigning contexts to the coefficients of each sub-band based on numbers of significant neighboring samples;

wherein the sub-bands include an LHH (low-high-high) sub-band and the contexts are assigned as follows:

LHH Sub-band			
h	v+a	d	Context
2	x	x	0
1	$\geq 3$	x	0
1	$\geq 1$	$\geq 4$	1
1	$\geq 1$	x	2
1	0	$\geq 4$	3
1	0	x	4
0	$\geq 3$	x	5
0	$\geq 1$	$\geq 4$	6
0	$\geq 1$	x	7
0	0	$\geq 4$	8
0	0	x	9

where "h" represents a number of immediate horizontal neighbors that are significant and  $0 < h < 2$ , "v" represents a number of immediate vertical neighbors that are significant and  $0 < v < 2$ , "a" represents a number of immediate temporal neighbors that are significant and  $0 < a < 2$ , and "d" represents a number of immediate diagonal neighbors that are significant and  $0 < d < 12$ .

13. (Once Amended) A method ~~as recited in claim 10~~, comprising:  
transforming frames in a video sequence using a wavelet transform and  
motion information between frames to produce multiple sub-bands of coefficients;  
coding the coefficients of each sub-band independently by assigning  
contexts to the coefficients of each sub-band based on numbers of significant  
neighboring samples;

wherein the sub-bands include an HHH (high-high-high) sub-band and the contexts are assigned as follows:

d	h+v+a	Context
$\geq 6$	x	0
$\geq 4$	$\geq 3$	1
$\geq 4$	x	2
$\geq 2$	$\geq 4$	3
$\geq 2$	$\geq 2$	4
$\geq 2$	x	5
$\geq 0$	$\geq 4$	6
$\geq 0$	$\geq 2$	7
$\geq 0$	1	8
$\geq 0$	0	9

where "h" represents a number of immediate horizontal neighbors that are significant and  $0 < h < 2$ , "v" represents a number of immediate vertical neighbors that are significant and  $0 < v < 2$ , "a" represents a number of immediate temporal neighbors that are significant and  $0 < a < 2$ , and "d" represents a number of immediate diagonal neighbors that are significant and  $0 < d < 12$ .

14. (Original) A method as recited in claim 1, further comprising truncating a number of bits in each bit-plane according to rate-distortion curves.

15. (Original) A method as recited in claim 1, further comprising estimating motion trajectories of pixels in a video object from frame to frame in the video sequence and said transforming is performed on corresponding pixels along the motion trajectories.

1       **16. (Original)** A computer-readable medium comprising computer-  
2 executable instructions that, when executed by one or more processors, perform  
3 the method as recited in claim 1.

4  
5       **17. (Once Amended)** A method comprising:  
6 estimating motion trajectories of pixels in a video object from frame to  
7 frame in a video sequence;

8 performing a temporal wavelet transform on the corresponding pixels along  
9 the motion trajectories in a temporal direction to produce frames of temporal  
10 wavelet coefficients;

11 performing a spatial wavelet transform on the frames of the temporal  
12 wavelet coefficients to produce multiple sub-bands of wavelet coefficients; and

13 coding each sub-band of wavelet coefficients independently bit-plane by  
14 bit-plane using different coding primitives, wherein the coding primitives  
15 comprise:

16 zero coding to code new information about a wavelet coefficient that  
17 is not yet significant in a previous bit-plane; and

18 sign coding to code a sign of the wavelet coefficient once the  
19 wavelet coefficient is deemed significant.

20  
21       **18. (Original)** A method as recited in claim 17, wherein the estimating  
22 comprises matching corresponding pixels in the video object from frame to frame  
23 in the video sequence.

1           19.    (Original) A method as recited in claim 17, wherein the temporal  
2 and spatial wavelet transforms comprise a shape-adaptive discrete wavelet  
3 transform.

4  
5           20.    (Once Amended) A method ~~as recited in claim 17~~, comprising:  
6           estimating motion trajectories of pixels in a video object from frame to  
7 frame in a video sequence;

8           performing a temporal wavelet transform on the corresponding pixels along  
9 the motion trajectories in a temporal direction to produce frames of temporal  
10 wavelet coefficients;

11           performing a spatial wavelet transform on the frames of the temporal  
12 wavelet coefficients to produce multiple sub-bands of wavelet coefficients;

13           coding each sub-band of wavelet coefficients independently; and

14           wherein the performing a temporal wavelet transform comprises:

15                 forming a pixel array containing pixels that continue from frame to  
16 frame in the video sequence;

17                 examining a pixel in a frame to determine whether the pixel is a  
18 terminating pixel that does not continue to a next frame;

19                 if the pixel is a terminating pixel, terminating the pixel array; and

20                 if the pixel is not a terminating pixel, adding the pixel to the pixel  
21 array.



1       **21. (Original)** A method as recited in claim 20, further comprising  
2 transforming the pixels arrays to produce the frames of temporal wavelet  
3 coefficients.

4  
5       **22. (Original)** A method as recited in claim 17, wherein the coding  
6 comprises transposing selected sub-bands to reduce a number of sub-bands to be  
7 coded.

8  
9       **23. (Original)** A method as recited in claim 17, wherein the coding  
10 comprises:

11       coding the wavelet coefficients in bit-planes; and  
12       allocating bits for the bit-planes according to a rate-distortion optimization.

13  
14       **24. (Original)** A method as recited in claim 17, further comprising  
15 truncating bits allocated to a bit-plane at a point on a rate-distortion curve that  
16 approximates a convex hull.

17  
18       **25. (Canceled)**

19  
20       **26. (Canceled)**

21  
22       **27. (Once Amended)** A method as recited in claim 25, comprising:  
23       estimating motion trajectories of pixels in a video object from frame to  
24 frame in a video sequence;  
25

1 performing a temporal wavelet transform on the corresponding pixels along  
2 the motion trajectories in a temporal direction to produce frames of temporal  
3 wavelet coefficients;

4 performing a spatial wavelet transform on the frames of the temporal  
5 wavelet coefficients to produce multiple sub-bands of wavelet coefficients; and

6 coding each sub-band of wavelet coefficients independently bit-plane by  
7 bit-plane using different coding primitives, wherein the coding primitives  
8 comprise:

9 zero coding to code new information about a wavelet coefficient that  
10 is not yet significant in a previous bit-plane;

11 sign coding to code a sign of the wavelet coefficient once the  
12 wavelet coefficient is deemed significant; and

13 magnitude refinement to code new information of a wavelet  
14 coefficient that has already become significant in the previous bit-plane.

15  
16 28. (Original) A method as recited in claim 17, wherein the coding  
17 produces multiple bitstreams for corresponding sub-bands of wavelet coefficients  
18 and further comprising constructing a multi-layer bitstream from the multiple  
19 bitstreams.

20  
21 29. (Original) A method as recited in claim 17, wherein the coding  
22 comprises assigning contexts to the wavelet coefficients of each sub-band based  
23 on numbers of significant neighboring samples.  
24  
25

1       **30. (Original)** A computer-readable medium comprising computer-  
 2       executable instructions that, when executed by one or more processors, perform  
 3       the method as recited in claim 17.

4  
 5       **31. (Previously Canceled)**

6  
 7       **32. (Previously Canceled)**

8  
 9       **33. (Previously Canceled)**

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 11       **34. (Previously Canceled)**

12  
 13       **35. (Previously Canceled)**

14  
 15       **36. (Once Amended)** A method comprising:  
 16       coding sub-bands of coefficients produced from transforming video frames  
 17       in an independent manner such that one sub-band of coefficients is coded  
 18       independently of another sub-band of coefficients; and  
 19       constructing a bitstream from the independently coded sub-bands; and  
 20       wherein the coefficients of each sub-band are coded bit-plane by bit-plane  
 21       using different coding primitives, wherein the coding primitives comprise:  
 22       zero coding to code new information about a coefficient that is not  
 23       yet significant in a previous bit-plane; and  
 24       sign coding to code a sign of the coefficient once the coefficient is  
 25       deemed significant.

37. (Original) A method as recited in claim 36, wherein the coding comprises transposing selected sub-bands prior to said coding.

38. (Canceled)

39. (Canceled)

40. (Once Amended) A method as recited in claim 38, comprising:  
coding sub-bands of coefficients produced from transforming video frames  
in an independent manner such that one sub-band of coefficients is coded  
independently of another sub-band of coefficients;  
constructing a bitstream from the independently coded sub-bands; and  
wherein the coefficients of each sub-band are coded bit-plane by bit-plane  
using different coding primitives, wherein the coding primitives comprise:

zero coding to code new information about a coefficient that is not yet significant in a previous bit-plane;

sign coding to code a sign of the coefficient once the coefficient is deemed significant; and

magnitude refinement to code new information of a coefficient that has already become significant in the previous bit-plane.

41. (Original) A method as recited in claim 36, wherein the coding comprises assigning contexts to the coefficients of each sub-band based on numbers of significant neighboring samples.

42. (Once Amended) A method ~~as recited in claim 41~~, comprising:  
coding sub-bands of coefficients produced from transforming video frames in an independent manner such that one sub-band of coefficients is coded independently of another sub-band of coefficients;

constructing a bitstream from the independently coded sub-bands;

wherein the coding comprises assigning contexts to the coefficients of each sub-band based on numbers of significant neighboring samples; and

wherein the sub-bands include an LLL (low-low-low) sub-band and an LLH (low-low-high) sub-band and the contexts are assigned as follows:

LLL and LLH Sub-bands				
h	v	a	d	Context
2	x	x	x	0
1	$\geq 1$	x	x	0
1	0	$\geq 1$	x	1
1	0	0	x	2
0	2	0	x	3
0	1	0	x	4
0	0	$\geq 1$	x	5
0	0	0	3	6
0	0	0	2	7
0	0	0	1	8
0	0	0	0	9

where "h" represents a number of immediate horizontal neighbors that are significant and  $0 < h < 2$ , "v" represents a number of immediate vertical neighbors

that are significant and  $0 < v < 2$ , "a" represents a number of immediate temporal neighbors that are significant and  $0 < a < 2$ , and "d" represents a number of immediate diagonal neighbors that are significant and  $0 < d < 12$ .

**43. (Once Amended)** A method as recited in claim 41, comprising:  
coding sub-bands of coefficients produced from transforming video frames  
in an independent manner such that one sub-band of coefficients is coded  
independently of another sub-band of coefficients;  
constructing a bitstream from the independently coded sub-bands;  
wherein the coding comprises assigning contexts to the coefficients of each  
sub-band based on numbers of significant neighboring samples; and

wherein the sub-bands include an LHH (low-high-high) sub-band and the contexts are assigned as follows:

LHH Sub-band			
h	v+a	d	Context
2	x	x	0
1	$\geq 3$	x	0
1	$\geq 1$	$\geq 4$	1
1	$\geq 1$	x	2
1	0	$\geq 4$	3
1	0	x	4
0	$\geq 3$	x	5
0	$\geq 1$	$\geq 4$	6
0	$\geq 1$	x	7
0	0	$\geq 4$	8
0	0	x	9

where "h" represents a number of immediate horizontal neighbors that are significant and  $0 < h < 2$ , "v" represents a number of immediate vertical neighbors

that are significant and  $0 < v < 2$ , "a" represents a number of immediate temporal neighbors that are significant and  $0 < a < 2$ , and "d" represents a number of immediate diagonal neighbors that are significant and  $0 < d < 12$ .

44. (Once Amended) A method as recited in claim 41, comprising:  
coding sub-bands of coefficients produced from transforming video frames  
in an independent manner such that one sub-band of coefficients is coded  
independently of another sub-band of coefficients;  
constructing a bitstream from the independently coded sub-bands;  
wherein the coding comprises assigning contexts to the coefficients of each  
sub-band based on numbers of significant neighboring samples; and

wherein the sub-bands include an HHH (high-high-high) sub-band and the contexts are assigned as follows:

d	h+v+a	Context
$\geq 6$	x	0
$\geq 4$	$\geq 3$	1
$\geq 4$	x	2
$\geq 2$	$\geq 4$	3
$\geq 2$	$\geq 2$	4
$\geq 2$	x	5
$\geq 0$	$\geq 4$	6
$\geq 0$	$\geq 2$	7
$\geq 0$	1	8
$\geq 0$	0	9

where "h" represents a number of immediate horizontal neighbors that are significant and  $0 < h < 2$ , "v" represents a number of immediate vertical neighbors that are significant and  $0 < v < 2$ , "a" represents a number of immediate temporal

neighbors that are significant and  $0 < a < 2$ , and "d" represents a number of immediate diagonal neighbors that are significant and  $0 < d < 12$ .

45. (Original) A method as recited in claim 36, wherein the constructing comprises forming multiple bit-planes and truncating a number of bits in each bit-plane according to a rate-distortion curve.

46. (Original) A computer-readable medium comprising computer-executable instructions that, when executed by one or more processors, perform the method as recited in claim 36.

47. (Cancelled)

48. (Cancelled)

49. (Cancelled)

50. (Cancelled)

51. (Cancelled)

52. (Cancelled)

53. (Cancelled)



1           **54.   (Canceled)**

2  
3           **55.   (Canceled)**

4  
5           **56.   (Canceled)**

6  
7           **57.   (Canceled)**

8  
9           **58.   (Canceled)**

10  
11           **59.   (Canceled)**

12  
13           **60.   (Canceled)**

14  
15           **61.   (Canceled)**

16  
17           **62.   (Once Amended) A video encoder as ~~recited in claim 61,~~**  
18 **comprising:**

19           a wavelet transformer to transform frames in a video sequence into multiple  
20 sub-bands of coefficients, the wavelet transform using motion information of  
21 video objects in the frames;

22           a coder to code the coefficients of each sub-band independently, the coder  
23 comprising a context-based arithmetic coder to assign contexts to the coefficients  
24 of each sub-band based on different coding primitives; and  
25

wherein the sub-bands include an LLL (low-low-low) sub-band and an LLH (low-low-high) sub-band and the coder employs a zero coding primitive to code new information about a coefficient that is not yet significant in a previous bit-plane by assigning the contexts as follows:

LLL and LLH Sub-bands				
h	v	a	d	Context
2	x	x	x	0
1	$\geq 1$	x	x	0
1	0	$\geq 1$	x	1
1	0	0	x	2
0	2	0	x	3
0	1	0	x	4
0	0	$\geq 1$	x	5
0	0	0	3	6
0	0	0	2	7
0	0	0	1	8
0	0	0	0	9

where "h" represents a number of immediate horizontal neighbors that are significant and  $0 < h < 2$ , "v" represents a number of immediate vertical neighbors that are significant and  $0 < v < 2$ , "a" represents a number of immediate temporal neighbors that are significant and  $0 < a < 2$ , and "d" represents a number of immediate diagonal neighbors that are significant and  $0 < d < 12$ .

63. (Once Amended) A video encoder as recited in claim 61, comprising:

a wavelet transformer to transform frames in a video sequence into multiple sub-bands of coefficients, the wavelet transform using motion information of video objects in the frames;

a coder to code the coefficients of each sub-band independently, the coder comprising a context-based arithmetic coder to assign contexts to the coefficients of each sub-band based on different coding primitives; and

wherein the sub-bands include an LHH (low-high-high) sub-band and the coder employs a zero coding primitive to code new information about a coefficient that is not yet significant in a previous bit-plane by assigning the contexts as follows:

LHH Sub-band			
h	v+a	d	Context
2	x	x	0
1	$\geq 3$	x	0
1	$\geq 1$	$\geq 4$	1
1	$\geq 1$	x	2
1	0	$\geq 4$	3
1	0	x	4
0	$\geq 3$	x	5
0	$\geq 1$	$\geq 4$	6
0	$\geq 1$	x	7
0	0	$\geq 4$	8
0	0	x	9

where "h" represents a number of immediate horizontal neighbors that are significant and  $0 < h < 2$ , "v" represents a number of immediate vertical neighbors that are significant and  $0 < v < 2$ , "a" represents a number of immediate temporal neighbors that are significant and  $0 < a < 2$ , and "d" represents a number of immediate diagonal neighbors that are significant and  $0 < d < 12$ .

64. (Once Amended) A video encoder as recited in claim 61,  
comprising:

a wavelet transformer to transform frames in a video sequence into multiple sub-bands of coefficients, the wavelet transform using motion information of video objects in the frames;

a coder to code the coefficients of each sub-band independently, the coder comprising a context-based arithmetic coder to assign contexts to the coefficients of each sub-band based on different coding primitives; and

wherein the sub-bands include an HHH (high-high-high) sub-band and the coder employs a zero coding primitive to code new information about a coefficient that is not yet significant in a previous bit-plane by assigning the contexts as follows:

d	h+v+a	Context
$\geq 6$	x	0
$\geq 4$	$\geq 3$	1
$\geq 4$	x	2
$\geq 2$	$\geq 4$	3
$\geq 2$	$\geq 2$	4
$\geq 2$	x	5
$\geq 0$	$\geq 4$	6
$\geq 0$	$\geq 2$	7
$\geq 0$	1	8
$\geq 0$	0	9

where "h" represents a number of immediate horizontal neighbors that are significant and  $0 < h < 2$ , "v" represents a number of immediate vertical neighbors that are significant and  $0 < v < 2$ , "a" represents a number of immediate temporal

neighbors that are significant and  $0 < a < 2$ , and "d" represents a number of immediate diagonal neighbors that are significant and  $0 < d < 12$ .

65. (Once Amended) A video encoder as recited in claim 61, comprising:

a wavelet transformer to transform frames in a video sequence into multiple sub-bands of coefficients, the wavelet transform using motion information of video objects in the frames;

a coder to code the coefficients of each sub-band independently, the coder comprising a context-based arithmetic coder to assign contexts to the coefficients of each sub-band based on different coding primitives; and

wherein the coder employs a sign coding primitive to code a sign of the coefficient once the coefficient is deemed significant by assigning the contexts as follows:

h=-1				H=0			
v	a	$\hat{x}$	Context	v	a	$\hat{x}$	Context
-1	-1	0	0	-1	-1	0	9
-1	0	0	1	-1	0	0	10
-1	1	0	2	-1	1	0	11
0	-1	0	3	0	-1	0	12
0	0	0	4	0	0	0	13
0	1	0	5	0	1	1	12
1	-1	0	6	1	-1	1	11
1	0	0	7	1	0	1	10
1	1	0	8	1	1	1	9

h=1			
v	a	$\hat{x}$	Context
-1	-1	1	8
-1	0	1	7
-1	1	1	6
0	-1	1	5
0	0	1	4
0	1	1	3
1	-1	1	2
1	0	1	1
1	1	1	0

where "h" represents a number of immediate horizontal neighbors that are significant and  $0 < h < 2$ , "v" represents a number of immediate vertical neighbors that are significant and  $0 < v < 2$ , "a" represents a number of immediate temporal neighbors that are significant and  $0 < a < 2$ , and  $\hat{x}$  is a sign symbol prediction in a given context.

66. (Canceled)

67. (Canceled)

68. (Canceled)

69. (Canceled)

70. (Canceled)

1           71. (Once Amended) A video encoder as ~~recited in claim 68~~,  
2 comprising:

3           means for estimating motion trajectories of pixels in a video object from  
4 frame to frame in a video sequence;

5           means for performing a temporal wavelet transform on the corresponding  
6 pixels along the motion trajectories in a temporal direction to produce frames of  
7 temporal wavelet coefficients;

8           means for performing a spatial wavelet transform on the frames of the  
9 temporal wavelet coefficients to produce multiple sub-bands of wavelet  
10 coefficients;

11           means for coding each sub-band of wavelet coefficients independently; and

12           wherein the means for performing a temporal wavelet transform comprises:

13               means for forming a pixel array containing pixels that continue from  
14 frame to frame in the video sequence;

15               means for examining a pixel in a frame to determine whether the  
16 pixel is a terminating pixel that does not continue to a next frame;

17               if the pixel is a terminating pixel, means for terminating the pixel  
18 array; and

19               if the pixel is not a terminating pixel, means for adding the pixel to  
20 the pixel array.

21  
22           72. (Canceled)

23  
24           73. (Canceled)

1 74. (Canceled)  
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3 75. (Canceled)  
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5 76. (Canceled)  
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7 77. (Canceled)  
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9 78. (Canceled)  
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11 79. (Canceled)  
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13 80. (Canceled)  
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17 82. (Canceled)  
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